7. Turn the blower on and move the glider slowly along the track. Check to see that the transfer wire does not touch the sparking wire or the spark paper. The gaps at both places should be as small as you can make them without rubbing. The sum of the two gaps whould not exceed 1 cm anywhere along the track. Rubbing at either place will alter the motion of the glider.

8. Use a small piece of adhesive tape to attach a strip of magnetic recording tape to the small glider. The recording tape should be attached at the same level as the upper surface of the air pulley (see Figure 4). The magnetic tape will then be parallel to the air track so a direct pull results.

9. Run the magnetic tape over the air pulley (see Figure 4).

Figure 4. The Air Pulley
By permission: The Ealing Corporation

10. Attach a 10 g slotted weight to the loose end of the magnetic tape with another small piece of adhesive tape.

11. Adjust the air supply to the pulley by turning the wing screw. NOTE: Too little air will cause the tape to touch the pulley; too much will cause it to fly off and the weight will fall to the floor.

12. You are now ready to attach the Basic Spark Source. USE CARE! OBSERVE ALL CAUTIONS.

13. Attach the alligator clip leads to the air track (see Figure 2)
    a) Attach the large wire (hot) with the red lead to the sparking wire near the rubber band launcher.
    b) Attach the small wire (ground) with the black lead to the end stop near the rubber band launcher.

14. Set the Timing Source Selector on the 10.0 Hz position. Note that the sparks will occur 0.1 s apart.

15. You may now plug in the Basic Spark Source but observe the following cautions:

CAUTIONS

1. Use the spark source only when recording. Do not fire it longer than necessary.
2. Never push the remote operate button without insuring a proper gap; in such a case, the discharge energy will occur internally. Continued operation without a proper gap (See Step 10) will damage the electronic components within the unit.
3. Unplug all spark sources when making lead changes; BE SAFE, assume the unit will misfire.

16. You are now ready to make your first recording:
    a) Push the glider back so the spring bumper just touches the bumper on the end stop.
    b) Simultaneously, release the glider and depress the remote operate button on the spark source
    c) Be sure to turn off (release) the remote operate button as soon as the glider reaches the opposite end of the track to avoid making spark holes on the return trip and confusing the record.

17. Unplug the spark source. BE SAFE!

18. Remove the small glider and replace it with a large one.

19. Adjust the spark transfer wire so it will record near the center of the spark paper (see steps 6 and 7).

20. Make your second recording (repeat steps 15 and 16).

21. Unplug the spark source. SAFETY FIRST!

22. Add another 10 g slotted weight to the free end with adhesive tape.

23. Adjust the spark transfer wire so it will record near the bottom edge of the spark paper (see steps 6 and 7).

24. Make your third recording (repeat steps 15 and 16).

25. You now have three records on spark paper. Unplug the equipment and put it away.

26. Tape the spark paper to a table and lay a meter-stick on it edgewise so the markings are adjacent to the spark holes. Do <u>not</u> place the end of the meter-stick on the first hole. Instead, put the one centimeter mark on the first hole and subtract it from all successive readings. Ignore the spark holes made when the bumpers were still in contact during launch.

27. Record the position of the holes for each of the three spark records in the proper place on the data sheet.

28. Calculate the average velocity for each interval for each spark record. The average velocity for a given interval is the instantaneous velocity at the mid-point of the interval.

29. Calculate the acceleration from the mid-point of one interval to the mid-point of the next interval for each successive interval. Record in the table: $a = (v - v_0)/t$

30. Average the accelerations you have listed in the tables for each spark record.

31. If the accelerating force is the same on two different objects, the acceleration ratio should equal the inverse of the mass ratio:

$$\frac{a_1}{a_2} = \frac{m_2}{m_1}$$

Weigh the masses on a balance scale and add the mass of the slotted weights. Neglect the mass of the magnetic tape. Compare the acceleration ratio (first and second spark records) and the mass ratio by finding the difference divided by the mass ratio. What factors cause the small difference?

32. Calculate the force ratio and the acceleration ratio (second and third spark records). These ratios should be equal. Compare by finding the difference divided by the force ratio. What factors cause the small difference?

EXPERIMENT 2

INFORMATION: Inertia is the property of matter that causes (1) a body at rest to remain at rest, or (2) a body in motion to remain in motion at constant velocity unless acted upon by an externally applied force. Newton's first law states that all matter has inertia. When you measure the mass of an object, you are measuring its inertia. A body of large mass has a large amount of inertia; a body of smaller mass has less inertia.

Weight is the pull of gravity on an object and is proportional to its mass. An object with a large mass will weigh a large amount; a small mass will weigh less.

EQUIPMENT:

1. Inertial balance (Sargent-Welch Cat.#0875)
2. Six 100 g slotted masses
3. One 3 in. C-clamp
4. One stop clock
5. Harvard trip balance
6. Various support rods and clamps

Check to see that all equipment listed is available. Obtain a data sheet from the instructor.

PROCEDURE

1. Securely clamp the inertial balance to a laboratory bench using the C-clamp. See figure 5.

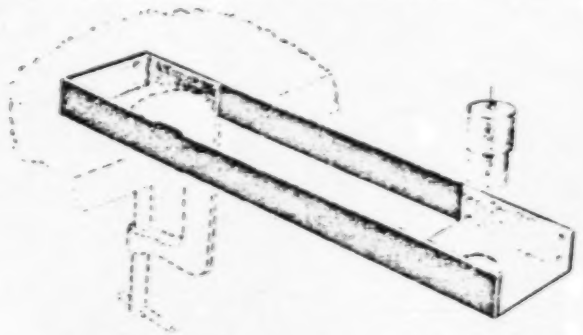

Figure 5. The Inertial Balance
By permission: The Sargent-Welch Scientific Co.

2. Plug the stop clock into a wall socket. Test the remote operating switch. NOTE: The clock is decimalized; each revolution of the large hand is ten seconds.

3. Place a 100 g mass in the center of the balance pan.

4. Deflect the balance pan about 3/8 to ½ in to one side by finger pressure. Release the balance so it oscillates freely.

5. After several oscillations, (when the mass stops moving on the pan) measure the time for fifty complete cycles.

   NOTE: Start the clock at one end of the swing; count "zero" at the same instant you start the clock.

   NOTE: Be sure to count complete cycles. One complete cycle is a swing over then back to the starting point.

6. Record the time for fifty cycles on the data sheet.

7. Repeat steps 4, 5 and 6, with 200 g, 300 g, 400 g, 500 g, and 600 g on the balance pan.

8. Calculate the frequency, period and square of the period for each trial and record on the data sheet.

9. On the graph paper provided, plot the mass horizontally and the period and the square of the period vertically. Which curve shows a linear relationship? Which variable is mass proportional to?

10. Remove the slotted masses from the pan and place the unknown mass through the hole in the balance pan. It should rest on the collar formed by the larger diameter.

11. Repeat steps 4, 5, and 6 with the unknown mass.

12. Determine the mass of the unknown by plotting the square of the period on the graph.

13. Assemble the stand, rod, clamp, and string as shown in figure 6. Suspend the unknown mass so the collar is not resting on the balance pan.

14. Repeat step 4, 5 and 6 with the unknown mass suspended.

15. Determine the mass as in step 12 and compare. Does the pull of gravity have a significant effect on the mass of the unknown?

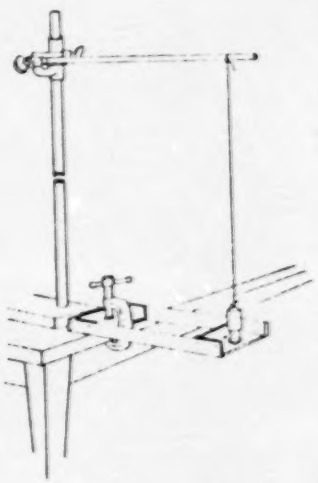

Figure 6. The Unknown Mass
By permission: The Sargent-Welch Scientific Company

16. Measure the mass of the unkown using the Harvard trip balance.

17. Calculate the percentage difference in the graph value of the unknown mass and that measured on the Havard trip balance.

18. Dismantle the equipment and put it away.